

ATTACHMENT 5

RESULTS OF THE STABILITY ANALYSES

BASE LINER CALCULATIONS

GREGORY CANYON LANDFILL

SEISMIC INDUCED PERMANENT DISPLACEMENT EVALUATION-BASE LINER CROSS-SECTION A-A'

PROCEDURE USED- Bray and Rathje (1998) and Bray et al (1998)

INPUT DATA:

SITE CONDITION- ROCK SITE

FILL HEIGHT, H

- 300 ft.

AVERAGE SHEAR WAVE VELOCITY FOR FILL, V_s

- 1200 ft/sec

EARTHQUAKE MAGNITUDE for the MCE

- 7.1 (on the Elsinore-Julian

Segment at ~6 miles)

MAXIMUM HORIZONTAL SITE ACCELERATION, MHA.

- 0.40g (mean value for the
MCE for the Site)

SIGNIFICANT DURATION – D_{5-95}

- ~16 Sec. (for the MPE,
Bray et al, 1998)

YIELD ACCELERATION, k_y

- 0.10g (from pseudo-static
analysis)

CALCULATION:

MEAN PERIOD OF SHAKING, for the MCE $T_m = 0.52$ Sec. (Bray et al ,1998),

PREDOMINANT PERIOD OF FILL-

$$T_s = 4H/V_s \\ = 4 \times 300 / 1200 = 1.0 \text{ sec}$$

RATIO $T_s / T_m = 1.0 / 0.52 = 1.92$

RATIO MHEA/MHA x NRF = 0.32 (from Bray and Rathje (1998), Figure 7b for rock site)

Where- MHEA- Maximum Horizontal Equivalent Acceleration of the fill

 MHA - Maximum Horizontal Site Acceleration

 NRF - Nonlinear Response Factor = 1.0

Thus, MHEA = 0.32 x MHA x 1.0

$$= 0.32 \times 0.40g = 0.13g$$

or, $k_{max} = 0.13$

Ratio $k_y / k_{max} = 0.10 / 0.13 = 0.77$

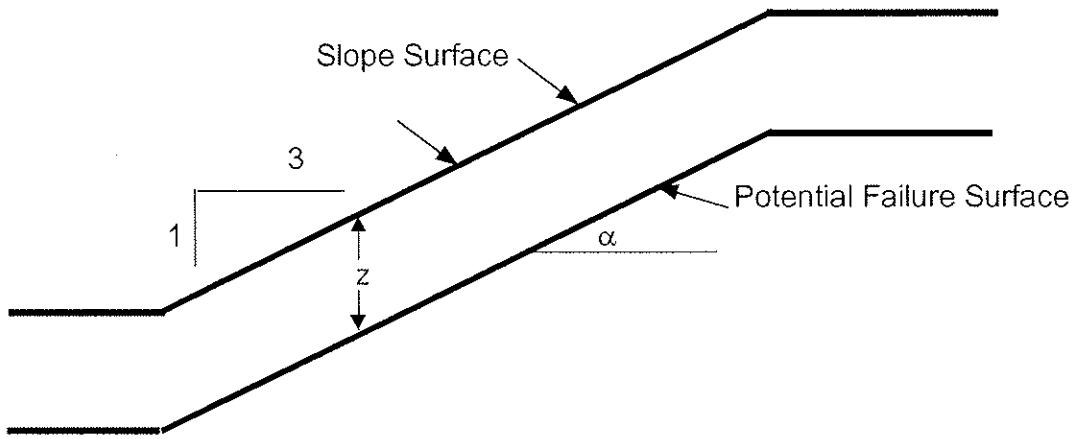
From Figure 11 of Bray and Rathje (1998): $U / (k_{max} D_{5-95}) = 0.15 \text{ cm/sec}$

Or, Displacement, $U = 0.15 \times 0.13 \times 16 = 0.3 \text{ cm (0.1 inches)}$

FINAL COVER CALCULATIONS

COVER SLOPE STABILITY ANALYSIS- INFINITE SLOPE

Gregory Canyon Landfill



Data:

Cover Thickness:	Z =	2 ft
Cover Soil Density:	γ =	100 pcf
Soil/Interface Layer Properties:	c =	0 psf
	ϕ =	27 degrees
Slope Angle (3:1, H:V)	α =	18.4 degrees
Assumes slope is drained		
Fill Slope		

$$1). \text{ Static Factor of Safety} = \frac{\tan \phi}{\tan \alpha} + \frac{2c}{\gamma Z \sin 2\alpha} = \underline{\underline{1.53}}$$

$$2). \text{ Pseudo-static Factor of Safety} = \frac{(1-k \tan \alpha) \tan \phi}{k+\tan \alpha} + \frac{c}{\gamma Z (\cos^2 \alpha)(k+\tan \alpha)}$$

Solve for Factor of Safety = 1.0:

Yield Acceleration = k

0.15 g

Pseudo-Static
Factor of Safety

1.00

Cover Component Stability Analysis, 40' high slopes with benches @3.5:1
Gregory Canyon Landfill, San Diego County, CA

Notes:
(1) Friction data courtesy of Serrtol International, Inc. as presented in "Static and Dynamic Stability Analysis Report, Phase V-D Expansion, Frank R. Bowerman Landfill, Irvine, CA," by IT Corporation, PN 779606, dated May 2001.

(2) Tensile strength from textured LDPE Geomembrane by Poly-Flex, Inc.

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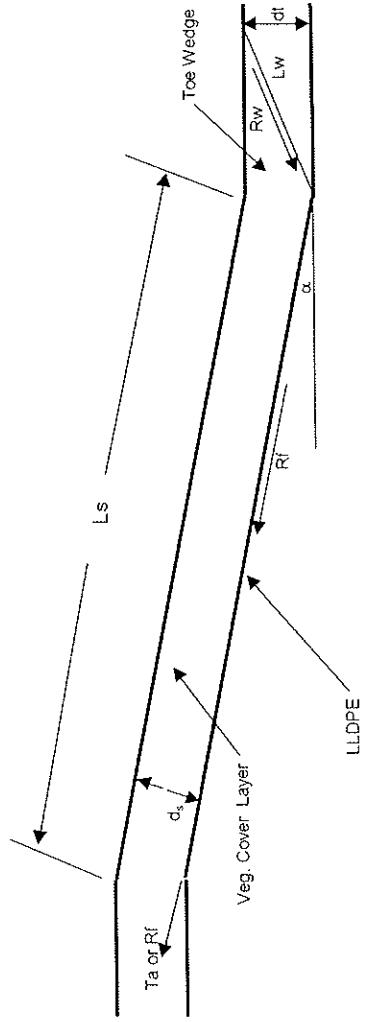
Conditions:

40° high slope

5
6

24 Vegetative Cover

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(Continued)
Cover Component Stability Analysis, Gregory Canyon Landfill, San Diego County, CA

Interface Friction Angle δ	Slope Inclination α	Geogrid/ Geonet Tensile Strength, T_u^* lbs/ft	Yield K_y^*	Acceleration K_y	Calculated Displacement (inches)
Vegetative cover/Textured LLDPE Geomembrane					
27	18.40	982	0.185	3/4 to 4-1/2 inches	

Case: 40' high slope between benches @ 3.0:1 inclinatio					
Vegetative cover/Textured LLDPE Geomembrane					
				Ls 126.79	
				Ky= 0.185	g lbs/ft
				Geogrid Tensile strength 982	
				FS**= 1.00	
				Ls 126.79	
				Ky= 0.15	g lbs/ft
				Geogrid Tensile strength 982	
				FS**= 1.01	Pseudo-static

Notes:

*Solve for T_u and K_y when $FS=1.00$

$$**FS = \frac{(L_s \gamma_s \delta_s L_s \cos \alpha) - (K_y \gamma_s \delta_s L_s \sin \alpha))(\tan \delta) + T_u}{(\gamma_s \delta_s L_s \sin \alpha + K_y \gamma_s \delta_s L_s \cos \alpha)}$$

**Equation adapted from Kramer, 1996, Geotechnical Earthquake Engineering, pg 434
Variables defined on previous page

SEISMIC INDUCED PERMANENT DISPLACEMENT EVALUATION-COVER
GREGORY CANYON LANDFILL

PROCEDURE USED- Bray and Rathje (1998) and Bray et al (1998)

INPUT DATA:

SITE CONDITION- ROCK SITE

FILL HEIGHT, H, feet	100'	200'	300'	400'	500'
SHEAR WAVE VELOCITY, V_s , ft/sec	650	800	900	1000	1100

(from Bray, et al., (1998), Figure 3)

EARTHQUAKE MAGNITUDE for the MCE: 7.1 (on the Elsinore-Julian Segment at ~6 mi.)

MAXIMUM HORIZONTAL SITE ACCELERATION, k_{max} 0.40g (mean value for the MCE for the Site)

SIGNIFICANT DURATION – D_{5-95} ~16 Sec. (for the MPE, Bray et al, 1998)

YIELD ACCELERATION, k_y 0.185g (from pseudo-static analysis for cover component, Table 3)

CALCULATION:

MEAN PERIOD OF SHAKING, for the MCE: $T_m = 0.52$ Sec. (Bray et al ,1998)

FILL HEIGHT, H, feet 100' 200' 300' 400' 500'

PREDOMINANT FILL PERIOD, T_s , sec 0.37 0.60 0.80 0.96 1.09
 $(T_s = 2.4H/V_s)$

RATIO $T_s/T_m =$ 0.71 1.15 1.54 1.85 2.10

RATIO MHEA/MHA x NRF = 1.2 0.96 0.83 0.80 0.76

(from Bray and Rathje (1998), Figure 8b for rock site)

Where- MHEA- Maximum Horizontal Equivalent Acceleration of the fill = k_{max}

MHA - Maximum Horizontal Site Acceleration

NRF - Nonlinear Response Factor = 1.0

Thus, calculate:

FILL HEIGHT, H, feet 100' 200' 300' 400' 500'

MHEA (or k_{max}): 0.48 0.38 0.33 0.32 0.30

Ratio of $k_y/k_{max} =$ 0.39 0.49 0.56 0.58 0.62

Calculate Displacement, U, from Figure 13 of Bray and Rathje (1998):

FILL HEIGHT, H, feet 100' 200' 300' 400' 500'

DISPLACEMENT, U, inches: 3.7" 1.8" 1.0" 0.8" 0.5"

SEISMIC INDUCED PERMANENT DISPLACEMENT EVALUATION-COVER
GREGORY CANYON LANDFILL

PROCEDURE USED - Makdisi and Seed (1978)

INPUT DATA:

SITE CONDITION- ROCK SITE

FILL HEIGHT, H, feet	100'	200'	300'	400'	500'
SHEAR WAVE VELOCITY, V _s , ft/sec	650	800	900	1000	1100

(from Bray, et al., (1998), Figure 3)

EARTHQUAKE MAGNITUDE for the MCE: 7.1 (on the Elsinore-Julian Segment at ~6 mi.)

MAXIMUM HORIZONTAL SITE ACCELERATION, k_{max} 0.40g (mean value for the MCE for the Site)

SIGNIFICANT DURATION – D₅₋₉₅ ~16 Sec. (for the MPE,
Bray et al, 1998)

YIELD ACCELERATION, k_y 0.185g (from pseudo-static analysis for cover component, Table 3)

CALCULATION:

FILL HEIGHT, H, feet	100'	200'	300'	400'	500'
PREDOMINANT FILL PERIOD, T _s , sec	0.37	0.60	0.80	0.96	1.09

(T_s = 2.4H/V_s)

$$\text{RATIO } k_y/k_{\max} = 0.185/0.40 = 0.46$$

From Figure 11b, Makdisi and Seed (1978), for k_y/k_{max}=0.46, Displacement, U/k_{max} g T=0.03

Therefore, Displacement U= 0.03(k_{max} g T_s)

$$U = 0.03 \text{sec} (0.40g) (32.2 \text{ ft/sec}^2) (T_s, \text{ sec})$$

FILL HEIGHT, H, feet	100'	200'	300'	400'	500'
CALCULATED DISPLACEMENT, U	<u>1.7"</u>	<u>2.3"</u>	<u>3.7"</u>	<u>4.5"</u>	<u>5.1"</u>